

SECTION 3

Current and Future Wireless Communications Requirements

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Current and Future Wireless Communications Requirements

This section presents the main research findings of this study, and establishes the requirements upon which the recommendations and proposed design are based.

Section 2 reviewed radio systems currently in use, along with the practices and environments in which they operate. Some aspects of these existing systems are functioning very well, and Nebraska can be proud of the way its public safety agencies perform.

Several typical scenarios below illustrate the range of situations faced by law enforcement, fire and rescue service providers. These “real life” examples are intended to help decision-makers understand the gravity of the need for radio system improvements in day-to-day as well as emergency activities.

Agency systems vary greatly in their ability to fulfill some or all of these needs. Most agencies paint compelling pictures of the deficiencies of their systems and how these impair safety and public service. Interoperability across jurisdictional boundaries is in the foreground, but interview and survey data reveals an array of immediate and future requirements—some very serious.

From the composite view of needs, events, and priorities presented in this section a unique set of challenges and opportunities emerges, against which solution alternatives can be matched.

Aspects of Existing Systems Working Well

When looking at the communications deficiencies experienced by public safety agencies, it would be tempting, but not correct, to conclude that no existing systems are performing well. Aspects of many of today’s radio systems that *are* functioning adequately are described below.

Internal Communications Support

Some existing radio systems are providing good internal communications. At the state level, the Department of Roads is satisfied with its existing low-band system, at least for its present needs. This system was designed and implemented primarily for internal communications, which comprise an estimated 90% of the department's total usage, and it handles this load well. Although the system is not new, it has been well maintained, and funding has been available to replace about 10% of the individual radios each year. Most agencies do not enjoy such consistent funding. Other examples of adequate internal communications include some of the criminal justice institutions and some of the areas under the jurisdiction of the Game & Parks Commission.

Additional examples of good internal communications are found among local agencies and especially consolidated areas. Sarpy, Lancaster, and Buffalo counties are in this group, which includes the most advanced 800 MHz systems, as well as VHF high band, UHF, and even some using low-band.

- “We have an adequate radio and paging system that has been very reliable.” — Custer County
- “Our system is adequate for our needs.” —Elba Fire and Rescue
- “[Our system] is second to none.” —Alliance Fire Department

Advanced Technology Deployment

Similarly, several systems use state-of-the-art technology which provides advanced features and functions, including in some cases vehicle-to-vehicle e-mail messaging.

- Lancaster, Sarpy, and Buffalo Counties have robust consolidated systems that provide trunking, wireless data support, and other advanced features.
- Douglas County has a well-implemented new consolidated dispatch center with advanced capabilities. They are experimenting with incorporating wireless data from Sarpy's system, and are considering radio consolidation with the City of Omaha Police Department.
- Many dispatch centers around the state use high-end consoles, including systems mentioned above. NSP has also installed state-of-the-art communications positions at three of its dispatch centers. These consoles are capable of adding computer-aided-dispatch (CAD) functionality.

Successful Dispatch Center Consolidations

All the communications center consolidations discovered during the course of this study can be termed successful. Some agencies that have yet to attempt consolidation are hesitant about the level of service to citizens in their areas. However, those who have already gone through the transition to joint operations are enthusiastic about its benefits.

- According to Harold “Pete” Peterson, director of the communications center in the 4-county Ogallala area, one of the keys to success lies in the training provided for dispatchers. Initially, user agencies outside Ogallala worried that the dispatchers would not know how to respond well to callers from other counties. With good training, however, this fear has been overcome. Ogallala Police Chief Joe Humphrey says consolidation is “great, because it gives me a chance to concentrate on other things rather than splitting the police and dispatch issues.” And Keith County Sheriff Earl Schenck adds, when asked if he was concerned about giving up control over dispatch, “What did I lose? Nothing I wanted.” Neither would go back to the former system of separate dispatch centers.
- The Seward County Sheriff and Seward Police recently consolidated their communications center so successfully that a second Police Department and all the fire and rescue units—a total of 17 agencies—have now joined in.

It’s not an easy thing, and there’s so much turfdom. We took two years of sitting around a table like this before we finally got it together, where we are feels good. Sometimes...we just need to agree to disagree and call it a deal. –Seward County 911 User Board Chair Larry Bonner

- Gering Police Chief Mel Griggs is an advocate for consolidation as well.

We went through consolidation, and I think we’re starting to realize that, if we’re going to get the high tech information and things we need to do it...it doesn’t make any sense to be separate.

Overall Emergency Responsiveness

Nebraska citizens enjoy a high level of service and commitment in vital public service areas. Ironically, public safety agencies’ resourcefulness and dedication masks their lack of adequate communications tools. When their radio systems are inadequate public safety employees, managers, and volunteers still step in and do the best job they can. They patch together resources from wherever they can find them and scramble to work around gaps they can’t fill. As a result, decision-makers seldom see the consequences and fail to provide funding that is really needed for replacement or system upgrades. Radio system functionality falls farther behind each year, until a major crisis calls attention to the problem that requires substantial funding to correct.

Typical Public Safety Scenarios

The requirement for effective wireless communications in the public safety arena can be readily illustrated by use of examples and typical scenarios. During this study, the consultants paid particular attention to anecdotes and stories supportive of the need for good radio systems and related human procedures. Effective inter-agency radio communications are required to sustain a high-level of coordination and effectiveness for the duration of the event. The absence of effective communications reduces the overall effectiveness of the efforts.

Special Coordinated Law Enforcement

It's common for two or more state, local, and combined law enforcement agencies to coordinate their efforts.

Scenario 1: Holiday weekends generally attract crowds to State Recreation Areas, and cooperative law enforcement operations manage crowds and handle related problems. The Game and Parks Commission, State Patrol, and local Sheriff's Department routinely work together to maintain order and safety by addressing boating, traffic, parks, and drug law enforcement, general crowd control, and other criminal activities. Interagency radio communications are vital for effective coordination of interagency efforts.

Scenario 2: The Game and Parks Commission, State Patrol, and Department of Roads collaborate in wildlife road checks by establishing an inspection point along Interstate 80. NDOR sets up a special pull-off lane, Conservation Officers sort traffic and send wildlife checks into wildlife check lanes. If other possible violations are noted, they direct vehicles to other agencies as appropriate (e.g., to NSP for traffic or drug checks or to Immigration and Naturalization to verify citizenship).

Criminal Long-Range Pursuit

Cooperative pursuit of a felon or suspect across a large region of the state or beyond by law enforcement agencies.

Scenario 3: The pursuit of suspected murderer Moses across southwestern Nebraska involved the State Patrol and local sheriff and police agencies. Law enforcement professionals point out that coordination of the capture effort was hampered by both the deficiencies of the Patrol's simplex low-band radio system and the lack of direct interoperability among local agencies in the path of the pursuit.

Scenario 4: A recent Lincoln bank robbery in which escaping suspects shot a farm couple raised concerns about the need for more effective interagency radio communications between the State Patrol and local law enforcement agencies.

Industrial Accident

Incidents involving private construction projects, manufacturing plants or similar facilities can result in significant damages, injuries, and effects on the wider community.

Scenario 5: The sugar refinery in Scottsbluff exploded, killing one person and seriously injuring several others, destroying four storage silos, and rippling the adjacent road. Many local agencies and the State Patrol were involved in the rescue and cleanup effort. Local interagency interoperability was partially successful, but portable radios needed to be traded with the State Patrol to provide interoperability with this agency.

Natural Disaster

A serious tornado, blizzard, or flood involves risks to life and property, damage to transportation and utility infrastructure, and disruption of many normal functions.

Scenario 6: After the 1990 tornado in Grand Island, many agencies worked for days on rescue and cleanup efforts. The destruction was tremendous. The State Fire Marshal, unable to communicate with the Grand Island FD or other agencies because their radio systems used different frequency bands, resorted to the payphone to coordinate his operations. Interoperable land mobile radio capability is required for effective Fire Marshal investigations.

Scenario 7: The October 1997 blizzard in eastern Nebraska paralyzed Lincoln and Omaha. The National Guard used chain saws to remove hundreds of downed trees. The trees were loaded onto NDOR trucks, but there was no overall communications command and control system established, and little radio interoperability. Consequently, NDOR drivers received conflicting orders from multiple agencies. Face-to-face was the only available method for communications, supported sporadically by cellular telephone.

National Security Incident

Rarely, an incident poses a serious threat to or damage to a facility with national security implications, invoking full federal cooperation with local and state authorities.

Scenario 8: When the Murrah Federal Building in Oklahoma City was destroyed by a terrorist bomb, rescue and investigative agencies at all levels of government from local to Federal poured on the scene. Although the individual agencies were equipped with quality radio communications systems, few were interoperative. Tactical street-level communications were accomplished using runners, hand signals, and shouts.

Transportation Incident

Accidents frequently strike trucks, trains, or airplanes, with associated injuries, damage, and hazardous material or other environmental risks.

Scenario 9: The airplane crash at Sioux City Airport ten years ago resulted in heavy casualties. Fire and rescue efforts drew from several counties, and Federal investigators asked local agencies to standby to assist. Radio interoperability was piecemeal and minimal.

Fatality Fire

Fires are regular occurrences in urban and rural areas. The extent of the resources that will be needed is often not known at the beginning; major grass fires can also cover very large areas and involve many injuries.

Scenario 10: Two fire investigators who were investigating a fire in which a fatality was suspected were forced to leave the scene by an encroaching wild field fire. They attempted to reach the State Fire Marshal for backup support, but experienced poor service because the transmitter was too distant for reliable operation. After many tries the message was conveyed via cellular phone, but valuable time was lost in the effort.

Routine Public Safety Coordination

Not all events in the public safety realm are as extensive as the ones above; many happen on a day in and day out basis at the local area level. These may be quite serious in themselves but do not engage as widespread a response.

Scenario 11: Investigating a bomb threat in a local school requires the services of the local police, sheriff, EMS squad, and fire department. Although in some communities many of these scares prove to be hoaxes, all appropriate public safety agencies must nevertheless respond to the scene.

Scenario 12: A gas main explosion in town also requires the presence of the above-mentioned agencies plus the responsible public service utility officials. Traffic must be re-directed around the scene, injured personnel removed from the scene to area hospitals, fires extinguished, and the source of the gushing gas shut off. All of these activities require close coordination of the responding public safety officials; effective radio communications are essential.

Analysis of Scenarios

Each of the above scenarios requires interagency radio communications to maximize efficiency and effectiveness of the overall effort. Each has a different characteristic profile and places different demands upon radio communications systems. Together these scenarios represent the spectrum of public safety events that this Plan must satisfy. A rating scheme consisting of six categories was developed to appraise each scenario and ensure that the full extent of each event is adequately represented. The categories are defined on the table below:

Scenario Factors	Definition
Severity	Relative: mild to heavy
Area	Geographical: small to wide
Response	Number of responding agencies

Agencies Law enforcement, fire, EMS, etc.
 Approach Reactive vs. planned response
 Duration Length of public agency operation

Rating the scenarios above on these factors illustrates the range of profiles any proposed system must encompass. Of course, the ratings themselves could vary depending on the specific circumstances of a given example. The chart on the next page presents a set of profiles for the scenario types.

	Severity	Area	Response	Agencies	Approach	Duration
Coordinated Enforcement	Mild	Small	2 - 4	LE	Planned	Short
Long-Range Pursuit	Heavy	Wide	1 - 4	LE	Reactive	Medium
Industrial Accident	Heavy	Small	2 - 5	All	Reactive	Short
Natural Disaster	Heavy	Wide	5	All	Planned	Long
National Security	Heavy	Varied	5	All	Planned	Medium
Transportation Incident	Medium	Small	1 - 5	All	Planned	Medium
Fatality Fire Incident	Mild	Small	1 - 2	Fire	Planned	Short
Routine Local Coordination	Medium	Small	1-3	Varies	Either	Short

Figure 1: Typical Public Safety Scenarios, Rated to Illustrate Variety of Profiles

Unmet System and Functional Needs

Existing systems have many deficiencies, as shown by the examples above. Over and over, study participants identified interoperability as their single most serious concern. Survey respondents, however, identified coverage as number one. This difference may be because coverage has many different aspects and causes, or it may reflect the fact that the majority of interviewees were top managers while survey respondents came from all levels in their organizations.

	Congestion	Coverage	Interference	Interop.	Reliability
Low-band	17%	39%	20%	11%	13%
VHF	13%	35%	15%	24%	13%
UHF	27%	27%	4%	23%	19%

Interoperability: the ability for radio users in different agencies and with different systems to communicate.

Coverage: The area in which service is available but also including capacity and related issues.

800 MHz	8%	38%	0%	31%	23%
All Users	18%	35%	14%	18%	15%

Figure 2: Top Concerns of Survey Respondents

Interoperability Shortfalls

Local agencies who have fully-consolidated systems, using radios in the same frequency band as well as common dispatchers, do not have interoperability problems for the most part. State agencies, although their own systems have limited functionality, are communicating on a regional level among their own field staff and in many cases with other state agencies in the same regions. The glaring gaps in the interoperability picture are at the area and statewide levels, and to a less urgent extent with other states and federal agencies.

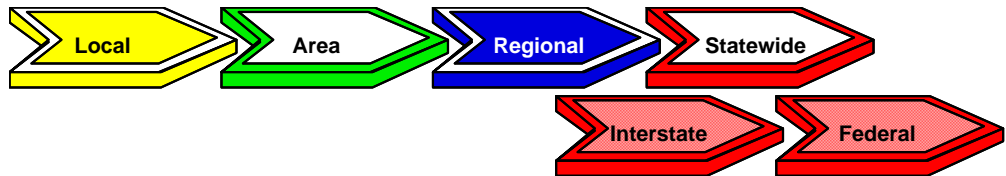


Figure 3: Local, Area, Regional, and State Agencies

“Everyone can call the consolidated center in Scottsbluff...well, *except the State Patrol.*”

—Bob Brower, Director,
Scotts Bluff County
Communications

Area Interoperability Gaps Between State and Local Agencies

Many of the most critical needs for interoperability are at the area level. In most areas of the state, considerable interplay may occur among the State Patrol, county sheriffs, and local police departments when a joint tactical operation arises. For example, when a state trooper stops a car on the highway, it is usually no problem to call an NSP dispatcher in the region. If the car doesn’t stop, however, the officer needs to be joined by the local Sheriff’s office, or if the chase enters a town, the police department. Another typical example is when G&P, as part of its emergency management role, needs interoperability with local agencies when it contributes assets to deal with a hazardous materials event or natural disaster.

The most often noted interoperative radio capability is the use of 39.9 MHz. Although most of the vehicles in the examples above have low-band radios, officers do not all automatically monitor this mutual aid frequency. Dispatchers for the respective agencies may contact the officers involved to switch to 39.9 MHz during the incident to effect direct interoperability.

Area Interoperability Gaps Among Local Agencies

Most laws are enforced, fires fought, and critically ill or injured people rescued, at the local area level.

“Down in Johnson County

, the hospital has an old, old system that might actually work on a good day. There’s an antenna on top of the hospital, and when the ambulances in Johnson County go out and pick up their new radio that cost a thousand dollars, it might be the best radio in the world but the hospital radio is so poor that it won’t even receive the signal.

—EMS Agent

“The bad guys

all communicate with each other. Something happens in Scottsbluff and the bad guys know all about it in Lincoln. There’s no reason why law enforcement shouldn’t have the same capabilities...It’s the 4-wheel drive syndrome: when you need it there’s not going to be anything else that will work.”

—Francis Coffey, NSP

“The decision to look at trunking at the new Tecumseh facility is a recognition by our agency that not only do we need to take advantage of the newer technologies ...but also beginning the transition from the individual islands to a fully-networked system.”

—Terry Ewing
DCS Security Director

Ambulances and air rescue units need to communicate with hospitals when they are carrying trauma cases. This is needed to coordinate medical care, and also to ensure that the destination trauma center is staffed and ready for the case on its way. Airborne EMS providers also require communications with the ground to ensure safe landings, and communications back to their own dispatchers for instructions and directions.

Statewide Interoperability Gaps Among Nebraska State Agencies

Varying degrees of requirements for tactical wireless interoperability among Nebraska state agencies were uncovered at the State Patrol (NSP), Department of Roads (NDOR), the law enforcement branch of the Game and Parks Commission (G&P), and the Department of Correctional Services (DOCS). Specific illustrative instances were cited by each agency wherein effective radio communications—had it been available—would have enhanced the protection of life and property and the effectiveness of the personnel involved. A few examples illustrate the hundreds told to the consultants:

- An NDOR salt truck driver spots a car in a ditch and needs to contact a nearby state trooper to assist the motorist.
- When dealing with a serious accident, a state trooper needs to contact an NDOR driver to block a highway.
- A G&P officer needs to contact an NDOR driver regarding the removal of a dead animal, or the reverse case where live animals are near highways and pose a threat to themselves and passing motorists.
- A DCS transport officer needs to contact the State Patrol to aid in recapture of an escaped prisoner.

Although many state agency vehicles are outfitted with low-band radios, they normally operate in different band segments, and can’t easily monitor the frequencies of the other agencies full-time. Requests for inter-agency communications as noted above are achieved by relaying messages between the dispatchers of the respective agencies—a time-consuming and inefficient method. On occasion, as described in the scenarios earlier in this section, some or all of these agencies engage in cooperative field operations in which effective communications are vital to success.

As noted earlier, NDOR primarily uses radio communications for internal purposes, and so has relatively less need for interoperability compared to law enforcement agencies. Their highest priority for interoperability is along the I-80 corridor, first with NSP and local law enforcement, then with EMS and fire departments. This could occur over a period of time; eventually NDOR wants to be capable of a high level of integration with the highway parts of state public safety efforts.

"Sioux City

[Iowa] hospitals don't have 39.82, so when our patients are transported, some of the ambulances had to buy a second radio to communicate with the hospitals. In other cases their ambulances are dispatched by 39.82 so our ambulances can talk to them, and they pass the information along to the hospitals. So it's catch as catch can up there."

—Eddy Williams
State EMS

The State Fire Marshal, like other investigators and emergency responders, needs a way to provide approach reports to other responding agencies as they come in. This is a very common requirement that in the current environment is often difficult to fulfill. However their biggest need for interoperability is with the State Patrol and Game and Parks, especially in the western parts of the state. Roads is also often the first agency that notices a fire in remote areas.

For the Department of Correctional Services, interoperability has a slightly different flavor. For inmate transports, requirements are basically the same as any other law enforcement function. Also on DOCS' horizon is the replacement of many of its institutional systems as well. While those systems are not part of the initial thrust of this study, in the long run they may be joining a new state system.

Interstate Communications among Nebraska and Adjacent States

Crime and natural disasters don't respect political boundaries; therefore Nebraska law enforcement agencies often communicate with their counterparts in the six adjacent states. Typically, dispatchers in their respective jurisdictions across the Nebraska boarder contact one another by landline telephone to monitor the available radio frequencies during the course of the event. In many instances VHF low-band is the common denominator. Some agencies in other states maintain a low-band radio operational mainly for interoperability with Nebraska.

Among state agencies, the Investigative Services Division of the NSP is most frequently involved in cases involving Federal agencies, such as the FBI, DEA, and the U.S. Marshal.

As discussed earlier, EMS providers often work across state boundaries in both directions—transporting patients between hospitals and trauma centers as needed for medical reasons.

Between State and Federal Agencies

Federal agencies such as the FBI and DEA may seek the cooperation of the State Patrol and local agencies in some cases during the conduct of enforcement operations. Presently, interoperation with Federal agencies consists of accepting a portable radio from the Federal officials and using it during joint operations.

Capacity and Coverage Gaps

The topic of "coverage" involves two independent components: Signal availability and Channel accessibility. Signal availability has to do with whether the radio can receive a transmission from the nearest transmitter location. Availability drops when the transmitter is too far away given the operating power of the transmitter or receiver, or there is interference or some other problem. Channel accessibility results from too few channels for the amount of traffic offered; there may be signal availability but no capacity to respond to the user.

"Our system is so bad we have troopers that have to get up on top of the overpasses on the Interstate to call in."

—Tom Venable
NSP Troop E

"If I'm in over my head, but I'm in a canyon...where I can barely talk on the radio to the nearest communications center, how can I talk to a physician 150 miles away?"

—Steve Ullrich
LifeNet Director of
Clinical Service

The absence of either of these two (signal availability or channel accessibility) may be perceived as a “coverage problem,” and they may be indistinguishable. The high importance rating given to coverage by survey respondents undoubtedly compounds the two. From the user’s standpoint, poor coverage is a serious issue, regardless of the cause.

“We hook and

crook it. We can call down to the Saline area dispatcher and maybe get through to them, and then ask them to bounce it back up here to our dispatcher. Or if we can’t get Saline, we might call York, and say “call my office and them tell I’m OK...”

Alan Baldwin
Seward Police Chief

100% coverage, while an ideal endorsed by the PSWAB, is not actually attainable. Research during this study revealed current coverage estimates ranging from 60 to 90 percent. It was unclear in some instances whether low coverage estimates were attributable to low signal availability or channel availability or both. The NSP’s assessment of coverage is at 90%—this estimate is for literal coverage of territories by radio engineering staff. Troopers in the districts may experience a significantly higher percentage of occasions when they are not able to use the system due to capacity, interference, and other factors. In addition, Game and Parks, which is much more likely to work in remote areas, has a much lower assessment of their percent coverage.

Whiteclay, now...the need for that tower comes and goes. For a long time, nothing was done because it wasn’t really critical.... last year there were tribal disputesAll of a sudden, it goes from nobody knowing about Whiteclay to the President of the United States showing up there...If you went through the state with a fine-tooth comb, you’d probably find a lot of these spots.—Ron Lehms, NSP

Agency Type	Low-band	VHF	UHF	800 MHz
Local Law Enforcement	27%	53%	27%	50%
Local Fire and Rescue Units	54%	24%	46%	25%
Other Local Agencies	8%	12%	18%	0%
State Departments	12%	12%	9%	0%
Percent of All Respondents	68%	17%	11%	4%

Figure 4: Percent of Survey Respondents Reporting Inadequate Coverage

Many comments were offered to the effect that the mutual aid frequency (39.9 MHz) becomes very congested during critical events, particularly in locales where paging is also conducted on this frequency. Where 39.9 MHz has been abandoned in favor of other frequencies, congestion is alleviated and the frequency has regained favor. Actual lack of low-band signal availability (vs. lack of channel capacity) has been cited in cases where law enforcement officers in distress have been unable to reach dispatchers for assistance.

Coverage is an issue wherever terrain is not flat, as in the western part of Nebraska and along the river in the east. Moving from a valley to the top of a hill, or from one side of a hill or a building to another, often makes the difference between the ability to use the system or not, but unfortunately, public safety events don’t confine themselves to convenient locations. Figure 4 summarizes the percentages of agencies that reported inadequate coverage in the survey responses.

Agency Type	Low-band	VHF	UHF	800 MHz
Local Law Enforcement	28%	49%	11%	0%
Local Fire and Rescue Units	53%	29%	65%	10%
Other Local Agencies	9%	17%	16%	0%
State Departments	10%	6%	8%	0%
Percent of All Respondents	62%	18%	19%	1%

Figure 5: Percent of Survey Respondents Reporting Interference Problems

Another aspect of coverage is the presence of interference that makes communications difficult or unintelligible. Figure 5 summarizes the same survey respondents' assessments of interference problems. Note that interference may be artificial or atmospheric; typical sources are ionospheric skip, storms, intergalactic radiations, electric motors, neon signs, electronic devices, vehicle ignition systems.

Analysis of available data suggests that both signal coverage and channel capacity are in short supply on many systems, particularly state agency systems. For survey respondents using low-band, for example, 44% report having inadequate channels. Altogether, agencies surveyed estimate that they would need at least 36% more low-band channels to meet these needs. However, many agencies that cite inadequate channels do not have any current plans for adding capacity, possibly due to a number of factors.

Agencies Reporting	Low-band	VHF	UHF	800 MHz
Channels Adequate	74 Agencies	36 Agencies	49 Agencies	11 Agencies
Channels NOT Adequate	57 Agencies	28 Agencies	14 Agencies	7 Agencies
Channels Adequate (%)	44%	44%	22%	39%

Figure 6: Estimated Channel Capacity Growth Requirements

"We want to be digital ready so we can go to wireless data within a couple of years."
—Bill Mizner, Chief of Police, Norfolk

Wideband Applications, Mobile Data and Other Enhanced Functions

Mobile data is fast becoming a necessity rather than an option for law enforcement. Nationwide, law enforcement agencies that have implemented the ability directly interrogate databases from their vehicles have measured clear gains in productivity and efficiency.

Today, the vast majority of public safety employees in Nebraska can only perform database inquiries from in-vehicle (for example, looking up driver information and outstanding warrants) by calling their dispatchers, who do the lookups using desktop computer terminals and relay the results by voice. This process is time-consuming and inefficient. It effectively precludes certain practices that have proven very effective, such as driving through rest areas and doing large batches of license tag checks.

The Nebraska Crime Commission is developing mobile data applications using TCP/IP protocols wherein a standard laptop computer installed in a vehicle equipped

with a data-capable radio can directly access data from local systems and CJIS¹, intelligence, NCIC, and other databases. The Commission is developing a universal incident reporting form, for example, which documents such events as traffic accidents. The incident data can be entered directly from a computer rather than from a paper form. When made available and adopted by criminal justice agencies, over-the-air database access and report generation may be expected to improve the productivity and efficiency of law enforcement in Nebraska.

Systems such as these have been proven to result in more time for police to do police work rather than paperwork. Relieving dispatchers of the responsibility to query databases in response to officer's demands frees them to devote more time to other collateral tasks, often including desk clerk duties and feeding prisoners.

Emergency Medical Services in some parts of the country also make use of wireless telemetry data links to relay medical data from ambulances en route to hospitals. In some cases, where higher levels of telemetry such as a multi-lead EKG are possible, the treatment options available during transport increase.² In addition, having this information in advance of the patient's arrival enables doctors to better prepare to treat the patient upon arrival.

In 1996, the Nebraska Department of Health³ established a State Trauma System Development Board, whose report, *Statewide Trauma System*, recommended coordination of trauma communications. This plan noted that, "The communications systems in Nebraska vary greatly from region to region depending on financial and personnel resources". It recommends a statewide trauma dispatch function, with access to up to the minute information about hospitals and trauma centers and the ability to connect with appropriate physicians while patients are en route. In addition, the plan recommends a uniform patient information system that would arrive ahead of the patient in the receiving emergency room. The Nebraska Ambulance Rescue Service Information System (NARSIS) provides uniform patient records and will someday be available in wireless mode in ambulances.

Among the many examples of data applications that could increase productivity—in addition to those discussed above—if they were available in the field are the following:

- Carrier Enforcement inspections reports
- Wants and warrant queries

Types of wireless data applications:

- Text (E-mail, reports)
- Database Queries
- Image (Mugshots)
- Fingerprint
- Video (Live incident scene)

¹ Criminal Justice Information System, an integrated state and local database system with multiple elements that support law enforcement, courts, and correctional facilities users.

² This is not always the case for basic life support transport, where the staff in the ambulance is not authorized to provide more complex treatments in any case.

³ Now the Health and Human Services System (HHSS).

- Vehicle registrations and driver license records
- Automatic log-in and log-out of officers
- Motor carrier credential checks
- Incident reports
- Service calls
- Automated officer reports
- Vehicle-to-vehicle messaging
- Intelligent highway system functions
- Highway construction data to field staff
- Remote monitoring of weather, road, and traffic conditions
- Records of drug investigations
- Correctional records and queries
- Parole officer reports and queries
- Fire reporting system access (NFRS)

Another mobile data capability of almost equal importance is vehicle tracking. Automatic Vehicle Location (AVL) systems rely upon Global Positioning Satellite (GPS) satellite networks to determine the latitude and longitude of an AVL-equipped vehicle and report the location to a central monitoring station. This data is then displayed as a point of light upon an area map on a computer display screen as well as tabular coordinates.

This accurate location data can be vital to the safety of both officers and the public, and can speed up mutual aid responses dramatically. For example, where the scene of an auto accident or plane crash is in a remote rural area, the precise coordinates can be used by rescue aircraft to fly directly to the scene, saving precious minutes for life-saving efforts. Even experienced public safety personnel can become lost during dark nights in remote back areas. The question “Where exactly am I?” can be answered by the dispatcher looking at the AVL map display. GPS has great applicability for both ground and air rescue services, where delays in locating remote accident sites can be critical.

Most of these data applications can easily be added to modern radio systems without stressing the capacity of the systems. This is because in most cases the computer applications can be developed so that only small, short bursts of data need to be sent through the air.

Some applications, including the use of video and graphics transmissions, require more capacity or bandwidth. For example, remote cameras can send video feeds from incident scenes to obtain law enforcement or medical help from a remote resource, or to record activities in real time for command coordination. Accident, crime, or natural disaster sites can thus be supported much more effectively and supervised much more closely.

Law enforcement activities are much enhanced by the use of text database support, but transmitting photographs (i.e., “mugshots”) or fingerprints in sufficient detail to be useful requires faster, higher-capacity transmission links. These applications are not widespread today, but their deployment is advancing nationwide at the same explosive rate as most other computer advancements. Very soon, support for mobile and remote video and graphics transmissions will become part of ordinary public safety capabilities rather than exotic “extras.” This has strong implications for Nebraska, where ordinary radio voice traffic is still problematic.

Finally, in this future of greater reliance on communications, security is a growing concern. Law enforcement and corrections officers are the most affected by security requirements. At the very least, voice security will assist officers doing investigations pursuing suspects.

Survey respondents in this study identified their known requirements for some advanced features and capabilities as shown in Figure 7 below. The data clearly indicates the current low deployment rates. Information on future plans is, however, probably estimated at unrealistically low levels. Many agencies that will need advanced capabilities may not yet recognize these needs, or may be struggling to upgrade routine voice radios.

Number of Respondents	No	Yes	Planned	Total
Mobile Data	237	27	12	276
Voice Encryption	245	26	9	280
Trunking	246	15	8	269
Digital Modulation	257	11	5	273
Narrowband	257	11	5	273

Figure 7: Estimate of Advanced Feature Requirements

Virtually Unlimited Capacity. Expert thinking about the future suggests that capacity will need to be virtually unlimited, and this is as true for wireless telecommunications as it is for wireline. Nebraska has recognized the validity of this concept in its plans for deploying the “TINA” digital voice and data network statewide. Similar focus on wireless communications is clearly indicated.

Uneven Quantities and Usefulness of User Equipment

While most state agencies report having enough radios, many of these are old enough to warrant replacement for both technical and functional reasons.

In the radio communications realm, obsolescence has historically been defined in terms physical age and dilapidation. Today, like all information technology equipment, radio gear may become obsolete for functional or technical reasons long before it

physically wears out. Not all those who make local and state level funding decisions have realized the implications of this change, and some still expect radio systems to last for decades. This has in some cases left public safety agencies at a disadvantage in serving the public and in the worst cases at serious risk of harm.

Owing to the variety and age of the radio equipment installed throughout Nebraska at all levels of government, a considerable range of functionality and capability exists. Most (if not all) of the vintage VHF low-band systems installed in Nebraska were designed for *simplex base station* operation, permitting the transmission of signals in either direction alternatively between the mobile and the base.

Under this arrangement, transmissions from the mobile units are not rebroadcast by the base station, so mobile-to-mobile communications are not enhanced. More modern system designs incorporate *half-duplex repeater* operation in which the mobile transmissions are rebroadcast via powerful base transmitters. The more recent land mobile radio installations in Nebraska are this type, and they support enhanced mobile-to-mobile and portable-to-portable communications. Low-band systems suffer from lack of adequate mobile-to-mobile communications owing to their simplex design.

Agencies Interested	Local Law Enf.	Fire & EMS	Other Local	State Agencies
Vehicle Location	28	51	7	13
Mobile Card Swipe	29	13	4	8
Mobile Data	41	39	7	11
Mobile E-mail	19	19	3	11
Mobile Identification	31	62	6	12
Mobile Printing	21	43	4	9
Mobile Video	35	26	5	6
Mobile Voicemail	21	24	1	9
Paging Capability	33	82	9	13

Many public safety agency vehicles are equipped with multiple radios with which to operate on the multiple radio frequency bands available at their respective locales. Some include scanners, CB radios, cellular telephones, and pagers. As many as five radios, microphones, and antennas are installed on some vehicles. Not only does this situation contribute to the clutter and inefficient use of space within the vehicle, it may also be a source of confusion to the officer attempting to identify the correct microphone to use in the heat of an emergency. To date, no manufacturer has produced a multi-band radio for use by public safety agencies. The addition of laptop computers to vehicles for mobile data use will compound the contention for interior vehicle space.

Figure 8: Estimated Additional Equipment Requirements

Simple to operate systems are also especially important to fire and rescue units, the vast majority of who rely on volunteer staffing. Volunteers may only rarely use the radios in their vehicles, making it difficult to support efficient use. Training and retraining of

both employees and volunteers is a continuing issue that impacts on the delivery of services.

A simple need that is often not met is the provision of mobile radio speakers and microphones in the backs of ambulances. Although outside the scope of this study, this unmet need was discovered in many places in the state. Providing radio service only for the drivers of the ambulances clearly misses an important aspect of service that should be addressed through appropriate means.

Capabilities reported by survey respondents are reported on Figure 8. The very high level of apparent interest in paging is due to the fact that many fire and EMS respondents are volunteers, and the ability to be located in an emergency is the most immediate of their needs. Most other agencies either have no separate capability for paging, or page over already-congested frequencies. Either way this is a difficult situation, even though it does not necessarily require advanced technology to resolve.

Aside from paging, the most-requested capability is Mobile Identification, which means the ability of a radio system to know which units are activated at any given time. A closely associated feature, Automatic Vehicle Location, tracks the specific locations of vehicles. These two features work together to provide dispatch centers the ability to find and appropriately support their field employees. Some of the interoperability needs experienced by agencies in joint operations have to do with converging on the scene of an incident. Across the wide Nebraska landscapes, AVL, and Mobile ID would be invaluable tools.

Non-Uniform Training and Maintenance

The Nebraska Law Enforcement Training Center (NLETC) in Grand Island, which is a function of the Crime Commission, offers public safety training for a variety of certification types, from law enforcement to EMS. Teaching participants how to use radios is a relatively small part of the curricula of most of these programs. However, since there are so many different radio systems and many different procedures for using the systems in the state, this training tends to be generic rather than specific. Because the effects of insufficient training are not easily or directly visible, these problems tend to be neglected or overlooked.

Communications dispatchers most often receive their training from NESCA instructors through a “Telecommunicator Course” offered at NLETC. In 1996, NESCA conducted a study of this training. They surveyed over a hundred of the course’s graduates and interviewed a balanced sample of working dispatchers and communications center managers, to learn what elements of training are essential, and what areas are not sufficiently addressed.

At present, there are no standards of performance and no mandatory standard training in Nebraska. *As the results of this Plan begin to be implemented, there will be an even more urgent need for agreement on these issues.*

- Nearly all of the administrators of dispatch center administrators favor developing operational standards and supporting training. Standards need to be developed with the participation of every public safety agency and need to be consistently committed to across the state.
- The average in-service training period for new dispatchers is eleven weeks. But even after the initial training, new dispatchers are often not fully comfortable with their knowledge of medical situations.

The level of public safety radio system maintenance and technician training vary throughout Nebraska correlating with the age and condition of the equipment (as discussed above). Many of the older VHF low-band systems suffer from the lack of availability of spare parts and may rely in certain instances on salvage parts from scrap units. The State Patrol and Game & Parks Commission reported that their low-band and high band systems, respectively, are kept minimally intact in anticipation of switching to the new statewide system when it becomes available. However, the Department of Roads reported that their low-band system is in relatively good repair, and that this agency has a scheduled replacement program for their radios. More recent radio systems operating on the upper frequency bands are maintained by a variety of methods, including government shops, manufacturer-provided service, and private local two-way radio shops. The quality of the services rendered varies on a case-by-case basis.

Land mobile radio technician training is vendor-specific. Technicians are sent to vendor-run schools at non-trivial expense to study the design theory, repair and maintenance techniques applicable to recent product offerings. Owing to proprietary considerations, the details vary considerably vendor-to-vendor. Likewise, the stocks of spare parts, components and test equipment required to be on-hand at service shops is also vendor-specific.

Opportunities and Challenges

The following is a summary of the requirements posed by the findings and needs assessment in this study. The proposed system must support:

Accommodating Many Systems and Users

The central challenge for Nebraska will be to fulfill the needs for interoperability without sacrificing investments in existing systems that are working well. The key requirements for primary users are as follows:

1. Statewide roaming: the ability for primary users to access the system from any location.
2. Statewide location: the ability for primary system users to locate any active radio user.
3. Universal interconnectivity among agencies when needed, with optional automation and acceptable connect delays.
4. Subscriber to subscriber communications (e.g., mobile to mobile, portable to portable, etc.).

Affordable and Robust Solution

Nebraska must also face the challenge of fulfilling system technical requirements while not compromising agency decision-making or imposing costs.

5. User autonomy with no state mandated but unfunded expenditures.
6. Mobile radio coverage of 90% in most areas, with 95% in selected areas as an option.
7. Channel availability of 95% and load management to ensure efficient use of capacity.
8. No single point of failure; all communications not lost in the event of a component being out of service.
9. Voice security available for all primary users.

Positioning for Future Flexibility

The solution for Nebraska must allow for long-term viability, and flexibility to meet changing conditions.

10. Planned growth in channels and infrastructure to meet projected requirements. “Virtually unlimited” future capacity for voice, data, graphics, and video.

“Small communities like ours need the state’s help with funding if we are ever going to be interoperable—we should be moving toward consolidated communications.”
—Scot Ford, Chief of Police, South Sioux City

11. Wireless data capability available to all users in the near future.
12. Advanced security availability (digital encryption).
13. Upgrade path for other advanced features.

Crafting a Smooth Migration Strategy

Change of the magnitude contemplated must take place in an orderly manner, recognizing the complexities of decisions to be made and the technical resources available.

14. Phased installation, with state level law enforcement agencies and functions as primary users, and a full array of options for participating or interfacing offered to other state and local users.
15. Universal training for all users and dispatchers with technical training fully funded

Facilitating Sharing and Coordination

Finally, among these requirements lies a great opportunity to facilitate interagency cooperation and joint operations, to the benefit of all.

16. Ease of use of subscriber equipment.
17. Standard procedures and that ensure efficient and coordinated use of the network elements.
18. Area consolidation and cooperation support.
19. Shared governance with no single agency responsible for system management, maintenance, or control.

